FEASIBILITY STUDY

Vasquez Boulevard/Interstate 70 Superfund Site
Operable Unit 2 – On-Facility Soils
Former Omaha and Grant Smelter

Prepared for

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August 20, 2010

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List of Acronyms

AOC	Administrative Order on Consent
ARARs	Applicable or Relevant and Appropriate Requirements
bcy	bank cubic yard
CAPPCA	Colorado Air Pollution Prevention and Control Act
CCoD	City and County of Denver
CCR	Code of Colorado Regulations or Construction Completion Report
CD	Consent Decree
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Recovery, Compensation, and Liability Act
CFR	Code of Federal Regulations
CRS	Colorado Revised Statutes
CSEV	Colorado Soil Evaluation Values
cu yds	cubic yards
CWA	Clean Water Act
cy	cubic yard
DADS	Denver Arapahoe Disposal Site
dl	deciliter
EMSI	Engineering Management Support, Inc.
FS	Feasibility Study
ft	feet
GIS	Geographic Information System
GRA	General Response Action
HHRA	Human Health Risk Assessment
I-70	Interstate 70
IC	Institutional Control
kg	kilogram
L	liter
Lcy or lcy	loose cubic yards
lf	lineal feet
lin	lineal
max	maximum
MCL	Maximum Contaminant Limit
mg	milligram
m^3	cubic meter
MSF	thousand square feet
NAAQS	National Ambient Air Quality Standards
NCP	National Contingency Plan
NESHAPs	National Emission Standards for Hazardous Air Pollutants
O&M	Operation and maintenance
OM&M	Operation, maintenance, and monitoring
OMB	Office of Management and Budget
OSHA	Occupational Safety and Health Administration
OU	Operable Unit

List of Acronyms (continued)

PPE	Personal Protective Equipment
RAOs	Remedial Action Objectives
RD/RA	Remedial Design/Remedial Action
RI	Remedial Investigation
SIP	State Implementation Plan
SLERA	Screening Level Ecological Risk Assessment
S/S	solidification/stabilization
sq ft	square feet
TBC	To be considered
TCLP	Toxicity Characteristic Leaching Procedure
UAO	Unilateral Administrative Order
μg	microgram
UNCC	Utility Notification Center of Colorado
U.S.C.	United States Code
USEPA	United States Environmental Protection Agency
VB	Vasquez Boulevard

1 INTRODUCTION

On behalf of the City and County of Denver (CCoD) pursuant to an Administrative Order on Consent (AOC) with the USEPA Docket No. CERCLA-08-2008-0011, Engineering Management Support, Inc. (EMSI) has prepared this Feasibility Study (FS) for Operable Unit 2 (OU-2) – On-Facility Soils, Former Omaha and Grant Smelter, of the Vasquez Boulevard and Interstate 70 (VB/I-70) Superfund Site (the Site). The Site is comprised of an approximately four square mile area located in the north-central portion of Denver, Colorado near the intersections of Interstate 70 and Interstate 25 (Figure 1).

As shown on Figure 2, the Site consists of the following three OUs:

- OU-1 – Off-Facility Soils that includes soils in the residential portions of the Superfund Site;

- OU-2 – On-Facility Soils which includes soils located in the vicinity of the former Omaha & Grant Smelter; and

- OU-3 – On-Facility Soils that includes soils located in the vicinity of the former Argo Smelter.

Previous investigations by USEPA identified the presence of levels of arsenic and lead in OU-2 soil at concentrations above human health screening levels. Therefore, the focus of the OU-2 Remedial Investigation (RI) was an assessment of arsenic and lead occurrences in surface and subsurface soil. An RI report for OU-2 that describes the Site history and physical setting, includes a summary of the investigations that have been completed at or in the vicinity of the Site, and provides an interpretation of the nature and extent of contamination (EMSI, 2009) has been prepared. A Baseline Human Health Risk Assessment (HHRA) [USEPA, 2009a] and a Screening-Level Ecological Risk Assessment (SLERA) [USEPA, 2009b] have also been prepared by EPA. The HHRA evaluated potential exposure for future residents, current or future commercial and construction workers, and recreational visitors. The SLERA qualitatively evaluated potential exposures of terrestrial plants to trace metals in surface and subsurface soil and aquatic receptors to trace metals in surface water and sediment along the South Platte River.

The results of the RI and HHRA indicate that metals in soil exist at levels necessitating remedial action to protect human health. The purpose of this FS is to serve as the mechanism for the development, screening, and detailed evaluation of alternative potential remedial actions for the Site to eliminate the potential for human receptors to be exposed to those contaminants. Specifically, the scope of the FS is to utilize the information developed during the RI and HHRA to:

- Develop specific remedial action objectives (RAOs);

- Identify and screen applicable remedial technologies;
- Develop and screen potential remedial alternatives; and
- Conduct a detailed evaluation and comparative analysis of remedial alternatives.

This FS report has been prepared, and the associated site investigations and risk assessments were conducted, in accordance with the requirements set forth in the National Contingency Plan (NCP) [USEPA, 2008] pursuant to the Comprehensive Environmental Compensation, Liability and Recovery Act (CERCLA) of 1980 as amended by the Superfund Amendments and Reauthorization Act of 1986. This report is organized in conformance with the suggested format of a Feasibility Study as identified in USEPA's *Guidance for Conducting Remedial Investigations/Feasibility Studies Under CERCLA* (USEPA, 1988). This FS report is composed of seven sections as outlined below:

- Section 1 discusses the purpose and scope of the FS as well as provides the regulatory framework under which the report is being prepared;
- Section 2 presents a brief background of the Vasquez Boulevard and Interstate 70 (VB/I-70) OU-2 Superfund Site, and summarizes the results of the RI, HHRA, and SLERA;
- Section 3 includes the development of RAOs and a discussion of potential applicable or relevant and appropriate requirements (ARARs) that may apply to any remedial action that may be taken at the Site. Section 3 also includes a presentation of general response actions as well as the identification and screening of remedial technologies and process options;
- In Section 4, remedial alternatives potentially capable of meeting the RAOs for the Site are developed and described based on those technologies/process options that met the screening criteria in Section 3;
- The detailed analysis of remedial alternatives is presented in Section 5;
- Section 6 includes a comparative analysis of alternatives; and
- A list of references is provided in Section 7.

Tables and figures follow the report text. The following appendices are included at the end of the report:

- Appendix A — Arsenic and Lead Soil Volume Estimates; and
- Appendix B — Estimated Costs for Remedial Alternatives

2 SITE BACKGROUND AND SUMMARY OF RI, HHRA, AND SLERA

A brief background of the OU-2 – On-Facility Soils, Former Omaha and Grant Smelter, of the VB/I-70 Site as well as summaries of the results of the RI, HHRA, and SLERA are provided in this section.

2.1 Background

The VB/I-70 Superfund OU-2 Site is located in the vicinity of the former Globe Smelter (Figure 2). The Globe Smelter is not part of the Site, but rather has been evaluated and remediated as part of a separate cleanup conducted by ASARCO, Inc. and overseen by the Colorado Department of Public Health and the Environment (CDPHE). Figure 3 shows the extent of the OU-2 Site as defined by USEPA and identifies the current land ownership for the area. The Site consists primarily of the southern portion of Denver Coliseum property (that portion of the Coliseum property located south of Interstate 70) which is owned by the CCoD, the Forney Transportation Museum property along Brighton Boulevard, the Pepsi Bottling Company property along Brighton Boulevard, and various other commercial properties located along Brighton Boulevard (Figure 3). The Site encompasses the approximately 50 acres of the original Omaha & Grant Smelter facility and includes a portion of the Globeville Landing Park. The Site is generally bounded by I-70 on the north, the South Platte River on the west, Brighton Boulevard on the east, and the southern boundaries of the Globeville Landing Park and the Pepsi Bottling Company property on the south.

The Omaha and Grant Smelter facility commenced operations at the Site in October 1882, was expanded in 1887 and again in 1892, when a 352-foot tall smelter stack was built. The smelter was closed in 1903. A lead smelting process was employed at the facility to produce gold, silver, copper, and lead. The process involved the fusing of ore, fuel, and lime to form a melted product. As a result of this process, lead and silver would sink to the bottom of an iron chamber and the slag would float on the surface of the liquid metals. Although detailed information about the wastes from the smelting operations is not well documented, it is known that blast furnace slag was produced from the smelting operations. Ores, fuel, and flux were delivered by rail car directly to the furnace charging doors on the upper levels of the smelter. As the smelting operations proceeded, the intermediate products flowed downhill to a lower level. Smelter workers would run slag onto a dump and load bullion onto rail cars.

After closure in 1903, the smelter buildings were subsequently demolished. Sometime later, all of the slag, with the exception of any residual that could be buried under modern parking lots, was removed. Based on historic aerial photographs, all of the visible slag was removed by 1949. Between 1920 and 1940, various portions of the facility were deeded to CCoD and other portions of the facility have been, and continue to be, owned or operated by the Union Pacific Railroad, the Pepsi Bottling Company and various other corporate entities or individuals. The properties still owned and used by CCoD are the Globeville Landing Park and the Denver Coliseum. The CCoD constructed the Denver Stadium and Coliseum circa 1950 and the Coliseum opened in 1952. The approximately 10-acre Globeville Landing Park was constructed in the 1970s.

Prior to constructing the Coliseum and associated parking lot, portions of the Site were used as a landfill for disposal of construction debris and possibly municipal solid wastes. The presence of the landfill materials beneath the Coliseum parking lot area is evidenced by the undulating nature of the parking lot pavement owing to differential compaction and decomposition of the underlying solid waste materials. No specific information or documentation of the time periods when the landfilling occurred, the nature of the landfill activities, or the nature of wastes disposed in the landfill could be located. Consequently, additional investigation of the nature, extent, and depth of the landfill materials was performed as part of the field investigations conducted for the RI.

Other than the South Platte River, there are no major surface water bodies within the Site area. Drainage in the Site area is largely controlled by man-made features such as ditches, roads, and storm sewers as the majority of the Site is paved or covered by buildings.

Previous investigations by USEPA (USEPA, 1998a) identified the presence of levels of arsenic and lead in soil at concentrations above human health screening levels. Therefore, the focus of the RI was on assessment of arsenic and lead occurrences in surface and subsurface soil. Previous groundwater sampling conducted by CCoD reported the presence of arsenic in one monitoring well at levels above state and federal drinking water standards. As it was only reported to be present in one well and there is no use of groundwater at or in the vicinity of the Site, USEPA concluded that groundwater was not a significant exposure pathway and therefore did not require additional investigations of groundwater conditions. Neither arsenic nor lead were detected at elevated levels in the upstream or downstream surface water or sediment in the South Platte River adjacent to the Site.

2.2 Summary of RI Report

The RI report includes assessments of the nature and extent of arsenic and lead occurrences in surface and subsurface soil. The fate and transport of these contaminants are also discussed in the RI report. The focus of the OU-2 RI was on assessment of arsenic and lead occurrences in surface and subsurface soil.

2.2.1 Arsenic and Lead in Surface Soil

Based on discussions with USEPA's risk assessors during preparation of the RI, surface soil was defined to be soil located from the ground surface to a depth of 12 inches, or for areas covered by pavement, the uppermost 12 inches of soil present beneath the pavement and any associated base course material. As investigations prior to the RI may not have collected samples exclusively from the uppermost 12 inches of native soil, results obtained from the uppermost samples obtained by these investigations (e.g., samples obtained from the 0 – 2 ft depth) were treated as surface soil samples. In instances where only composite samples that included the uppermost 12 inches plus a substantial amount of subsurface soil (e.g., composite sample from a 0 – 10 ft interval) were collected, results for these samples were evaluated in the RI as both surface and subsurface soil samples. Arsenic and lead analytical results obtained during the RI investigations combined with the results obtained during prior investigations for surface soil samples collected in the OU-2 Site area are presented on Figures 4A and 5A, respectively.

2.2.2 Arsenic and Lead in Subsurface Soil

Arsenic analytical results obtained during the RI investigations combined with the results obtained during prior investigations for subsurface soil samples collected in the OU-2 Site area are presented on Figures 4B and 4C for the "5- 10 ft" and "greater than 10 ft" depth samples, respectively. Lead analytical results for subsurface soil samples are presented on Figures 5B and 5C.

2.3 Contaminant Fate and Transport

Surface and shallow subsurface soil containing arsenic and lead could be subject to erosion and subsequent transport as windblown material or as suspended phase material in stormwater. As the majority of the Site is covered with buildings or pavement, these processes are not considered to be significant for OU-2.

Arsenic and lead occurrence in soil are subject to potential leaching. Precipitation at the ground surface results in soil moisture that can be evaporated, be transpired by vegetation back to the atmosphere, or, in response to further addition of moisture from subsequent precipitation events, move vertically downward through the soil column. As soil moisture moves downward it has the ability to pick up (leach) chemicals present in the soil and transport those chemicals further downward in the soil column or potentially down to the underlying groundwater. The leaching potential of arsenic and lead is a function of the amount of soil moisture and magnitude of the soil moisture flux, the oxidation-reduction conditions of the soil moisture, and the presence of organic acids or other agents that could act to increase the mobility of these trace metals. Leaching potential may be offset by the sorption potential of the underlying soil which will tend to restrict soil moisture transport and also act to remove the trace metals from the soil moisture.

As the vast majority of the surface of OU-2 is covered with buildings, asphalt, or concrete and is subject to stormwater diversion and control, infiltration of precipitation into the underlying soil is extremely limited. Consequently, the amount of water being added to the soil moisture over time is small and therefore, the soil moisture flux is anticipated to be small. Leaching could be more significant in areas where pavement is not present or where the overlying pavement is depressed, fractured, disintegrated, or otherwise would act to focus stormwater into areas where it could potentially drain into the underlying soil. Visual inspection of the Site did not indicate any significant areas where these conditions currently exist. Overall, leaching is not expected to be a significant process for chemical transport at the Site. As discussed in the RI Report (EMSI, 2009), the lack of significant leaching is supported by the overall lack of elevated occurrences of arsenic or lead in the groundwater samples.

The overall fate of the arsenic and lead chemical occurrences in OU-2 is to remain sorbed onto the soil beneath the Site. Due the presence of buildings and pavement that prevent erosion and subsequent windblown or stormwater transport and that greatly limit the amount of soil moisture, significant transport and migration of the arsenic and lead chemical occurrences from the soil is not expected to occur.

2.4 Summary of the HHRA

A Baseline HHRA for OU-2 was prepared by USEPA (USEPA, 2009a). The HHRA identified incidental ingestion of surface and subsurface soil, surface water, or sediment by current or future on-site commercial workers, construction workers, recreational visitors or by future residents to be the primary exposure pathways of potential concern. As discussed in the HHRA, four different exposure areas were identified for future residents and two different exposure pathways were identified for current or future commercial and construction workers. Residential exposure unit R-1 includes the current Pepsi Bottling Company property located in the southeastern portion of OU-2 (Figure 6). Residential exposure unit R-2 includes the business located along Brighton Boulevard and the Forney Transportation Museum property in the northeastern portion of OU-2 (Figure 6). Residential exposure units R-3 and R-4 include the northern and southern portions of the Denver Coliseum property, respectively (Figure 6). Potential exposures by recreation visitors were limited to exposure to surface water and sediment along the South Platte River. The following chemicals of potential concern were identified and evaluated by the risk assessment:

Chemical	Soil	Sediment	Surface Water
Antimony	X		
Arsenic	X	X	X
Cadmium	X	X	X
Cobalt	X		
Copper	X	X	X
Iron	X		
Lead	X	X	X
Manganese	X		
Silver	X		
Thallium	X		
Vanadium	X		
Zinc	X	X	X

Both potential risks from cancer and non-cancer health effects from possible exposures to these chemicals were quantitatively evaluated in the HHRA. Exposures to lead were also evaluated relative to the probability that exposure could result in a blood lead value of concern to a fetus (blood lead level greater than 10 micrograms per deciliter [ug/dl]).

Based on the evaluations conducted for the risk assessment, exposure to lead from incidental ingestion of soil by a pregnant commercial or construction worker is of potential concern in commercial exposure unit C2 (generally the Pepsi property and other commercial properties along Brighton Boulevard) [Figure 6]. Exposure to lead through incidental ingestion of soil by a pregnant construction worker is also a potential concern for residential exposure unit R2 (generally the commercial properties along the northern portion of Brighton Boulevard) [Figure 6].

Ingestion of surface soil containing arsenic, manganese, and thallium was identified as a potential concern for future residents in residential exposure unit R-2. Exposure to lead in soil was identified as a potential concern for a future child resident in residential exposure units R1, R2, and R3.

The results of the risk assessment indicated that there is little risk to recreation visitors who may have contact with surface water or sediment along the South Platte River.

2.5 Summary of the SLERA

A SLERA for OU-2 was prepared by USEPA (USEPA, 2009b). The SLERA qualitatively evaluated potential exposures of terrestrial plants to trace metals in surface and subsurface soil and aquatic receptors (fish, benthic macro invertebrates, and amphibians) to trace metals in surface water and sediment along the South Platte River. These evaluations were performed by comparing the trace metal concentrations at the Site to benchmark values that are believed to be without significant risk of unacceptable adverse effects.

Because the concentrations of metals in soil vary from location to location, and because plants are not mobile, each soil sample was evaluated as an individual exposure point. The detected concentrations (or in the case of non-detect results one-half the detection limit) of metals at each sample location were compared to benchmark values. USEPA Ecological Soil Screening Levels (USEPA, 2003b) and lowest observed effect concentrations determined by Oak Ridge National Laboratory (Efroymson et al. 1997) were used as benchmark levels for terrestrial plants. Average soil concentrations measured by the U.S. Geological Survey (Shacklette, and Boerngen, 1984) in Colorado counties near the Site (Arapahoe, Douglas, and Jefferson) were used to represent State background. These values were also compared to the benchmark values as it is considered likely that if the hazard quotients for the State background levels exceed the benchmark values, the benchmark values may be overly conservative since risks to plants are not expected in background soils.

These evaluations indicate that levels of arsenic and lead, and perhaps a few other metals in soils from areas within the former smelter area and known slag deposits may be within range of potential phytotoxicity in some locations. There are few locations where concentrations of arsenic and lead in surface soil could currently be phytotoxic to plants. Most of the locations that are of potential concern are in subsurface soils. Therefore, the predicted risks are not currently of concern, but could be of concern if soils became exposed and subsurface materials were brought to the surface.

For surface water and sediment, the 95% upper confidence limit values calculated from the Site data were compared to USEPA's National Ambient Water Quality Criteria (USEPA, 2002). The levels of metals detected in surface water at both the upstream (USEPA, 2009b) and downstream sampling locations along the South Platte River were less than the benchmark values. This indicates that any impacts of groundwater discharging from the Site to the South Platte River are not of ecological concern. With the exception of lead in the upstream sample location, the levels of metals detected in sediment at both the upstream (USEPA, 2009b) and downstream sampling locations along the South Platte River were less than the benchmark values. This indicates that any impacts of groundwater discharging from the Site and potentially impacting sediment in the South Platte River are not of ecological concern to benthic organisms in sediment.

3 RAOS, ARARS, ACTION LEVELS, AND IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section includes discussions of remedial action objectives (RAOs), potential ARARs, action levels, general response actions (GRAs) that will satisfy the RAOs, and identification and screening of technology types and process options.

3.1 Remedial Action Objectives

The initial step in identifying remedial alternatives in the FS is to formulate RAOs. RAOs are media-specific goals designed to protect human health and the environment. RAOs specify the contaminants of concern and media of interest, exposure pathways, and remediation goals that permit a range of alternatives to be developed on the basis of chemical-specific ARARs and site-specific, risk-related factors.

As discussed previously, surface and shallow subsurface soil media are of concern at the Site. The following preliminary RAOs have been identified for these media and the Site:

- Limit exposure of commercial and construction workers to lead in commercial exposure unit C-2 (Pepsi Property and commercial properties along Brighton Boulevard); and

- Limit or prevent exposure of potential future residential users to:

    - Lead in residential exposure units R-1, R-2, and R-3 (all areas of the Operable Unit except the south half of the Denver Coliseum parking lot); and

    - Metals (arsenic, manganese, and thallium) in residential exposure unit R-2 (commercial properties along Brighton Boulevard and the Forney transportation museum property).

3.2 Potential Applicable or Relevant and Appropriate Requirements

Section 121(d) of CERCLA, 42 U.S.C. Section 9621, states that remedial actions on CERCLA sites must attain (or justify the waiver of) any federal or more stringent state environmental standards, requirements, criteria, or limitations that are potential ARARs. Applicable requirements are those cleanup standards, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that while not applicable, address problems or situations sufficiently similar to the circumstances of the proposed response action and are well-suited to the conditions of the particular site.

Pursuant to USEPA guidance, ARARs generally are classified into three categories: chemical-specific, location-specific, and action-specific requirements. Chemical-specific ARARs include those laws and requirements that regulate the release to the environment of materials possessing certain chemical or physical characteristics or containing specified chemical compounds. These requirements generally set numerical health- or risk-based concentration limits or discharge limitations for specific hazardous substances. Location-specific ARARs are those requirements that relate to the geographical or physical position of the site, rather than the nature of the contaminants of concern or the proposed site remedial actions. Action-specific ARARs are requirements that define acceptable handling, treatment, and disposal procedures for hazardous substances.

A requirement may not meet the definition of an ARAR, but still may be useful in assessing whether to take action at a site or to what degree action is necessary. This can be particularly true when there are no ARARs for a site, action, or contaminant. Such requirements are called "to be considered" (TBC) criteria. TBC criteria are nonpromulgated advisories or guidance issued by a federal or state government that are not legally binding, but that may provide useful information or recommended procedures for remedial action. Although TBCs do not have the status of ARARs, they are considered together with ARARs to establish the required level of cleanup for protection of human health or the environment. The critical difference between a TBC and an ARAR is that one is not required to comply with or meet a TBC when deciding on a remedial action. However, should a TBC be established as a cleanup standard in the ROD, then the TBC effectively produces the same results as an ARAR.

Descriptions of potential chemical-specific ARARs, lists of the various numerical limits associated with the potential chemical-specific ARARs, location-specific requirements that were considered to be either applicable or potential relevant and appropriate for the Site, and potential ARARs that may be applicable to remedial actions that may be implemented at the Site are provided in Table 1.

3.3 Action Levels

As indicated in the HHRA (USEPA Region 8, 2009a), the current land use at the VB/I-70 OU-2 site is primarily commercial/industrial, with recreational use at the Globeville Landing Park that includes a small portion of western corner of the site immediately adjacent to the South Platte River. Consistent with the current and foreseeable land uses at OU-2, the HHRA evaluated potential exposures associated with commercial works, construction workers, and recreation visitors.

The HHRA also included evaluation of potential hypothetical future residential use of the OU-2 site in the event that the site was ever redeveloped from commercial/industrial use to residential use. This evaluation was done in part to evaluate potential risks if land uses at the site were unrestricted, and in part, at the request of the City and County of Denver, to allow for evaluation of what actions might be necessary should the land use at OU-2 ever change in the future.

This feasibility study looks at remedial alternatives necessary to protect human health based on commercial/industrial use of the site. Commercial/industrial is the primary current use and the reasonably anticipated future land use for the OU-2 site. Current land uses at the site include the Denver Coliseum buildings and parking lots, the Forney Transportation Museum and associated parking areas, the Pepsi Bottling Company facility, and several smaller businesses located along Brighton Boulevard. With the exception of the Forney Museum, which re-located to this area only a few years ago, all of these businesses/facilities have been present at this location for many years. The land uses in the area surrounding the site are also primarily commercial/industrial. The site is also located at the intersection of two major interstate highways. Consequently, there are no plans or expectations to change the land use from commercial/industrial in the near future or that the site will be redeveloped for residential uses in the foreseeable future. Therefore, the remedial alternatives developed and evaluated in this feasibility study are focused on exposures associated with commercial/industrial uses.

Based on the results of the risk assessment, exposures to soil containing lead was the only chemical that presented a potential risk to workers and then only to pregnant commercial or construction workers (EPA, 2009). Although the HHRA determined that arsenic occurrences in soil did not pose and unacceptable risk to workers, the potential cancer risks to commercial workers posed by arsenic occurrences in soil were estimated by the HHRA to be 1×10^{-5}. The NCP states that the "The 10^{-6} risk level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available or are not sufficiently protective because of the presence of multiple contaminants at a site or multiple pathways of exposure. As there are no ARARs for occurrences of arsenic in soil, the FS will also consider arsenic occurrences in soil during the development and evaluation of potential remedial alternatives.

EPA (2009) and CDPHE (2007) have established risk-based action levels for lead and arsenic based on worker exposures or commercial/industrial land uses. These values are summarized below:

EPA and CDPHE Soil Remediation Goals for
Worker Exposures or Industrial/Commercial Land Uses

Trace Metal	CSEV* (mg/kg)	EPA PRG** (mg/kg)
Arsenic	1.6	1.6
Lead	800	800

* Colorado Soil Evaluation Value (CSEV) [CDHPE, 2007]
** EPA Preliminary Remediation Goals (EPA, 2009)

The arsenic value of 1.6 mg/kg is less than the background level of 15 mg/kg established by the OU-1 RI for area soils (Washington Group, 2001) and is less than the 70 mg/kg action level established by EPA in the Record of Decision for OU-1 (EPA, 2003). Consequently, the action level of 70 mg/kg established by EPA for OU-1 will also be considered as an action level for purposes of completing the FS for OU-2. Both CDPHE and EPA have established a risk-based level of 800 mg/kg for worker exposures to lead and therefore this value will be used as an action level for purposes of completing the FS for OU-2.

As discussed in Section 2, analytical results obtained during the various Site investigations for soil samples in the "0 to 5 feet", "5 to 10 feet", and "10 feet and greater" depth intervals, respectively are provided in Figures 4A though 4C for arsenic and in Figures 5A through 5C for lead. Areas where concentrations of arsenic in surface and subsurface soil exceeded the 70 mg/kg action level in the "0 to 5 feet", "5 to 10 feet", and "10 feet and greater" depth intervals are shown in Figures A-1 through A-3, respectively, in Appendix A. Areas where lead in surface and subsurface soil exceeded the 800 mg/kg action level in the "0 to 5 feet", "5 to 10 feet", and "10 feet and greater" depth intervals are shown in Figures A-4 through A-6. Figures A-7, A-8, and A-9 in Appendix A depict the areas where soil samples with concentrations of arsenic greater than 70 mg/kg and/or lead greater than 800 mg/kg were collected in the "0 to 5 feet", "5 to 10 feet", and "10 feet and greater" depth intervals.

The areas in Figures A-7 through A-9 were estimated using Geographic Information System (GIS) software through development of Thiessen polygons around each soil sample and soil boring location. Thiessen polygons are polygons whose boundaries define the areas closest to each sample point relative to all other sample points. They are mathematically defined by the perpendicular bisectors of the lines between all points.

3.4 Identification of General Response Actions, Technologies, and Process Options

In this section, GRAs, technologies, and process options are described and an overview of the process used to identify and screen technologies is provided. The overview is followed by a detailed discussion of the GRAs, and the identification and screening of technology types and possible process options.

3.4.1 General Response Actions

After RAOs are established for a site, media-specific GRAs are developed to satisfy the RAOs for the exposure area. GRAs are media-specific actions that have the ability to meet the RAOs for the exposure area. Once GRAs are determined, a screening of potential technologies and process options can be conducted in the context of the GRAs. Technologies that pass both the screening steps and the GRAs will be used as the basis for development of a series of remedial alternatives that could be applied to the exposure unit to meet the RAOs. The RAOs were described previously in Section 3.1.

Based on the current understanding of the contaminants of concern and environmental conditions associated with the Site, GRAs that could be implemented to achieve the RAOs for soil are included on Figure 7. For the surface and shallow subsurface soil, the GRAs include the following:

- ***No-Action:*** No attempt is made to satisfy the RAOs and no remedial measures are implemented. No-Action is required for consideration by the NCP as a basis against which the other alternatives are compared.
- ***Institutional Controls:*** Non-engineering methods by which access to contaminants of concern in soil is physically or administratively restricted or regulated, and/or monitored.
- ***Monitoring:*** Monitoring of land uses and sampling/analysis of various media to assess changes in chemical concentrations.
- ***Operational Controls:*** These controls would include engineered methods such as access restrictions (e.g., fencing).
- ***Physical Containment:*** Technologies that would prevent direct contact with contaminants of concern in soils, immobilize contaminants of concern, and/or prevent infiltration of surface water.
- ***Contaminant Mass Reduction:*** Physical, chemical, and/or biological methods by which contaminants of concern are removed from the soil and treated aboveground or disposed off site.

3.4.2 Technologies and Process Options

For each GRA, broad technology groups and specific process options that could be used to implement these actions are identified. Technologies refer to general categories (e.g., chemical treatment or biological treatment). Process options refer to the specific processes within each technology type (USEPA, 1988). As discussed in Section 4, the No-Action GRA is included to provide a reference with which to compare the other alternatives that are developed.

Evaluation of potentially applicable technology types and process options is a key step in the FS process. The criteria for identifying potentially applicable technologies are provided in USEPA guidance (USEPA, 1988) and in the NCP (USEPA, 2008). A strong statutory preference for remedies that are reliable and provide long-term protection is identified in Section 121 of CERCLA, as amended. The primary requirements for a final remedy are that it be both protective of human health and the environment and cost effective. Hence, candidate technologies and process options need to be capable of satisfying these key factors. Summaries of potentially applicable remedial technology types and process options for soil are illustrated in Figure 7.

3.4.3 Presumptive Remedy for Metals-in-Soil Sites

Since Superfund's inception in 1980, USEPA's remedial and removal programs have found that certain categories of sites have similar characteristics, such as the types of contaminants present, sources of contamination, or types of disposal practices. Based on the information acquired from evaluating and cleaning up of these sites, the Superfund program has developed presumptive remedies to accelerate cleanups at certain categories of sites with common characteristics. The presumptive remedy directive *Presumptive Remedy for Metals-in-Soil Sites (USEPA, 1999b)* establishes preferred technologies for metals-in-soil waste such that the technologies/process options screening and detailed analysis of alternatives steps in the FS can be streamlined.

As discussed in the *Presumptive Remedy for Metals-in-Soil Sites* directive, a determination is to be made whether the nature of the metal wastes in soils at the Site are principal threat wastes or low-level threat wastes. Principal threat wastes are source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. Examples include surface soil or subsurface soil containing high concentrations of contaminants of concern that are (or potentially are) mobile due to wind entrainment, volatilization, surface runoff, or sub-surface transport; and highly-toxic source material, such as soils containing significant concentrations of highly toxic materials. No "threshold level" of toxicity/risk has been established to equate to "principal threat." However, where toxicity and mobility of source material combine to pose a potential risk of 10^{-3} or greater, then the presumptive remedy treatment alternative of reclamation/recovery should be evaluated. If the site-specific determination is made that reclamation/recovery is not well-suited for the waste at a site, immobilization is the presumptive remedy for principal threat waste.

Low-level threat wastes generally include contaminated source material of low to moderate toxicity, such as surface soil containing contaminants of concern that generally are relatively immobile to air or groundwater (i.e., non-liquid, low volatility, low leachability contaminants such as high molecular weight compounds) in the specific environmental setting; and low toxicity source material, such as soil and subsurface soil concentrations not greatly above reference dose levels or that present an excess cancer risk near the acceptable risk range. For low-level threat waste found at metals-in-soil sites, the presumptive remedy is containment.

Reclamation/recovery is a permanent treatment technology that separates metal contaminants from soil in the form of metal, metal oxide, ceramic product, or other useful products that have potential market value. Reclamation/recovery is usually preceded by physical separation and concentration (e.g., soil washing) to produce uniform feed material and/or to upgrade metal content or enhance separation performance. Reclamation/recovery may be the primary treatment method and may include hydrometallurgical or leaching processes. Compounds in waste can also be converted to metal or matte by transferring undesirable components to a separate slag phase. Subsequent treatment can be performed to upgrade the metal or matte. Further management of materials left over may be required to protect human health and the environment once metals are recovered.

Immobilization includes processes that change the physical or chemical properties that impact the leaching characteristics of a treated waste or decrease its bioavailability and concentration. This treatment method locks metals within a solidified matrix (solidification) and/or converts the waste constituent into a more immobile form, usually by chemical reaction (stabilization). The process involves mixing a reagent (usually cement kiln dust, cement, fly ash, blast furnace slag, bitumen, and proprietary agents) and generally solidifying the material with the contaminated soil. Reagents are selected based on soil characteristics and metal contaminants present. Immobilization can be performed ex-situ or in-situ, and in either on- or off-site units. Immobilized materials generally are managed in a landfill with the associated containment barriers (e.g., caps).

Containment of metals-in-soil waste includes vertical or horizontal barriers. These remedial technologies can provide sustained isolation of contaminants and prevent mobilization of soluble compounds over long periods of time. They also reduce surface water infiltration, control odor and gas emissions, provide a stable surface over wastes, limit direct contact, and improve aesthetics. Institutional controls generally are used in conjunction with containment to further limit the potential for unintended access to the waste materials.

As discussed in Section 2, the surface and shallow subsurface soil at the Site contaminated with metals is a low-level threat waste. Therefore, the presumptive remedy of containment will be developed as a remedial alternative in Section 4.

3.5 Technical Implementability Screening of Remediation Technologies and Process Options

The universe of potentially applicable technology types and process options applicable to each identified GRA, as well as any presumptive remedy technologies, are initially reduced by evaluating the options with respect to technical implementability. Technologies and process options for the soil GRAs were identified and screened for technical implementability. Screening results are summarized in Figure 7.

As shown on Figure 7, the process options that are the presumptive remedy for metals-in-soil sites principal threat wastes (i.e., the in-situ solidification/stabilization [S/S] immobilization and reclamation/recovery technologies) and that are not cost-effective unless addressing very significant volumes of soil (excavation/on-site landfill) were not retained as a result of the technical implementability screening. Although the surface and shallow subsurface soil at the Site is not a principal threat waste, the presumptive remedy immobilization technology of ex-situ S/S was retained because some off-site disposal facilities may require that excavated soil with metals concentrations above certain levels undergo S/S prior to disposal.

3.6 Evaluation of Retained Process Options

Technologies and process options considered to be technically implementable are evaluated in greater detail on the basis of effectiveness, implementability (both technical and administrative), and relative cost as defined by the following factors:

- Effectiveness - In terms of protecting human health and the environment in both the short term and the long term;
- Implementability - In terms of technical feasibility, resource availability, and administrative feasibility; and
- Cost - In a comparative manner (i.e., low, moderate, or high) for technologies of similar performance and/or implementability.

These evaluation criteria are applied only to the GRAs and technologies being evaluated to meet the RAOs for the Site and not to possible combinations of these technologies and process options that might be combined to form remedial alternatives.

Technologies and process options that are not effective in protecting human health and the environment, that cannot be implemented because of the physical characteristics of the site or contaminants of concern, or that have a cost that is an order of magnitude greater than a similar technology are eliminated during this phase of the screening. In accordance with USEPA guidance (1988), effectiveness is the major emphasis of this screening evaluation. Less weight is given to implementability and cost. The technologies and process options that are retained after the effectiveness, implementability, and cost screenings are assembled into remedial alternatives in Section 4.

The evaluation of soil remediation process options for effectiveness, implementability, and cost is presented in Figure 8. In accordance with USEPA guidance (1988), representative process options are selected to simplify the development and evaluation of alternatives. However, the specific process option used to implement a remedial action may not be selected until the remedial design phase. Selection of a representative process option does not preclude the application of other retained process options at the Site.

4 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

This section identifies and describes the remedial alternatives potentially applicable to the Site. Due to the limited number of potential alternatives, no screening of the alternatives was performed and all of the alternatives are subjected to detailed evaluation in Section 5 of this FS pursuant to the nine criteria identified in the NCP.

As indicated in the HHRA (USEPA, 2009a), the current land use at the VB/I-70 OU-2 site is primarily commercial/industrial, with recreational use at the Globeville Landing Park that includes a small portion of the western corner of the Site immediately adjacent to the South Platte River. Consistent with the current and foreseeable land uses at OU-2, the HHRA evaluated potential exposures associated with commercial workers, construction workers, and recreation visitors.

The HHRA also included evaluation of potential hypothetical future residential use of the OU-2 site in the event that the site was ever redeveloped from commercial/industrial use to residential use. This evaluation was conducted in part to evaluate potential risks if land uses at the site were unrestricted, and in part, at the request of the CCoD, to allow for evaluation of what actions might be necessary should the land use at OU-2 ever change in the future.

The FS looks at remedial alternatives necessary to protect human health based on commercial/industrial use of the Site. Commercial/industrial is the primary current use and the reasonably anticipated future land use for the OU-2 Site. Current land uses at the Site include the Denver Coliseum buildings and parking lots , the Forney Transportation Museum and associated parking areas, the Pepsi Bottling Company facility, and several smaller businesses located along Brighton Boulevard. With the exception of the Forney Museum, which relocated to this area only a few years ago, all of these businesses/facilities have been present at this location for many years. The land uses in the area surrounding the site are also primarily commercial/industrial. The Site is also located at the intersection of two major highways. Consequently, there are no plans or expectations to change the land use from commercial/industrial in the near future or that the Site will be redeveloped for residential uses in the foreseeable future. Therefore, the remedial alternatives developed and evaluated in this feasibility study are focused on exposures associated with commercial/industrial uses.

4.1 Listing of Alternatives

The following remedial alternatives have been identified for the VB/I-70 OU-2 Site:

Alternative 1 - No Action

Alternative 2 - Institutional Controls

Alternative 3 - Capping

Alternative 4 – Excavation/Disposal of Soil

4.2 Description of Alternatives

Details regarding each of the four remedial alternatives are provided below. Multiple technologies are associated with Alternatives 3 and 4.

4.2.1 Alternative 1 - No Action

No engineered measures or monitoring would be implemented to reduce contaminant concentrations, prevent chemical migration, restrict or eliminate potential exposures to Site chemicals, or reduce exposure of chemical concentrations to potential human receptors. The No Action Alternative is required by the NCP to provide a baseline for evaluation/comparison of the costs and benefits of other alternatives.

4.2.2 Alternative 2 - Institutional Controls

Institutional Controls (ICs) are non-engineered instruments such as administrative and/or legal controls that minimize the potential for human exposure to contamination by limiting land or resource use (USEPA, 1998b and 2000a). At sites where wastes are left in place that would not result in unrestricted land use and unlimited exposure, ICs are included as part of the remedial actions to ensure that unacceptable exposure from residual contamination does not occur.

The objectives of ICs that may be applied to the VB/I-70 OU-2 Site include the following:

- Prevent residential land use by restricting land uses to commercial or industrial uses in areas where residual contamination will remain in place at concentrations that are above the levels that would allow for unrestricted use;

- Require appropriate health and safety and materials management procedures for any excavations conducted in conjunction with subsurface infrastructure upgrades, repairs or replacements in areas of residual contamination; and

- Require implementation of appropriate remedial actions in conjunction with any building demolition or redevelopment activities that may occur in the future in the areas of residual contamination.

The mechanisms that may be used for implementation of ICs for the VB/I-70 OU-2 Site include (1) governmental controls, (2) proprietary controls, (3) enforcement and permit tools with IC components, and (4) informational devices. Monitoring and reporting of the development, implementation, and effectiveness of the various ICs will also be required.

Although there currently are zoning regulations in place that specify the allowable land uses for the property, the zoning of the property could be subject to change in the future. Therefore, institutional controls to prevent residential use of the property in the future are necessary. Furthermore, USEPA guidance on use of ICs (USEPA, 2000a) recommends use of layered ICs; that is several overlapping types of controls, of which zoning and platting regulations only represent one type of control.

For this Alternative 2, it is assumed that ICs to restrict land uses to commercial/industrial type uses on-site and to require development of and adherence to a Health and Safety Plan for soil excavation activities would be developed, applied, and maintained. A Materials Management Plan would also be developed and implemented to insure sampling and proper management of potentially contaminated soil. Areas that would be subjected to ICs are shown on Figure 9.

4.2.2.1 Governmental Controls

Governmental controls include regulations adopted by government agencies such as CCoD that have authority to implement controls or limits on land use at the Site. Governmental controls that could be applied to the VB/I-70 OU-2 Site include:

1. Zoning restrictions and/or overlay districts that specify and control allowable land uses and restrict residential uses to areas meeting standards for unrestricted use; and

2. Building permit notifications and restrictions identifying the potential for contamination, existence of restrictions on land uses, and requirements for evaluation of suitability of particular parcels for proposed structures/uses.

4.2.2.2 Proprietary Controls

Proprietary controls include items such as environmental covenants or environmental easements that are recorded against a particular piece of property and run with the land. An environmental covenant may be developed to restrict the following types of land uses:

1. Prevent residential uses in areas with chemical concentrations above risk-based levels for unrestricted use;

2. Require notification of intent to perform any subsurface excavation and require evaluation of appropriate health and safety and materials management requirements.

Environmental covenants and restrictions could be developed and recorded against the property deed to identify and describe the restrictions that would be imposed on future use of the property. Environmental covenants would be designed in accordance with the requirements of the Colorado Environmental Covenants law. The environmental easements would be developed and granted to the agencies to insure adherence to environmental covenants and governmental controls and to provide the agencies with a mechanism for legal enforcement of the covenants and controls against future property owners.

4.2.2.3 Enforcement Tools

An enforcement mechanism such as a Consent Decree (CD) or Unilateral Administrative Order (UAO) will be developed by EPA requiring implementation of the selected remedial actions for the Site. This enforcement tool will require development of an Institutional Controls Plan and adoption and implementation of ICs for the Site. The CD or UAO will also require monitoring and reporting of current and proposed land uses relative to land use restrictions and ongoing assessment of the compliance with and the effectiveness of the adopted ICs.

4.2.2.4 Informational Devices

Informational devices may also be part of the ICs to be used for the Site. These could include deed notices identifying presence of contamination, land use restrictions, and requirements for land use. The presence of contamination and restrictions on land uses at the Site could also be identified in various planning documents prepared by CCoD.

The property will also be added to the database of the Utility Notification Center of Colorado (UNCC), the excavation notification service for Denver area. Listing on the Utility Notification Center of Colorado database will provide a mechanism to notify potential contractors of the presence of contamination, and the restrictions and requirements for excavation at the site, and also a mechanism to notify the CCoD of potential excavation activities that may be conducted at the Site.

4.2.2.5 Monitoring and Reporting

Monitoring and reporting of the development, implementation, and effectiveness of the various ICs will also be required. This would include monitoring of land uses and documentation of acceptability of land uses in areas of contamination that remain at concentrations greater than levels that would allow for unrestricted use. It is anticipated that such monitoring could include:

1. Visual and/or aerial photograph inspection of existing land uses;

2. Monitoring by CCoD Department of Environmental Health – Division of Environmental Quality of rezoning applications, hearings and decisions; subdivision and platting applications, hearings and decisions; grading and building permit applications and issuances; and

3. Participation by CCoD Department of Environmental Health – Division of Environmental Quality in long-range land-use planning activities that encompass the area of the Site to insure that the contamination issues and land use restrictions are identified and considered in such plans.

4.2.2.6 Application of Institutional Controls

EPA recommends that ICs to be layered and/or placed in series to provide overlapping assurances of protection from exposure to contamination resulting in an increase in overall effectiveness and reliability of ICs (EPA, 2000a). Layering means using different types of ICs at the same time to enhance the protectiveness of the selected alternative. Using ICs in series means the use of different ICs at different points in the investigation and remediation process to ensure short and long term protection of public health and the environment.

In the case of OU-2, one or more of the all four types of ICs (governmental controls, proprietary controls, enforcement tools, and information devices) may be developed and applied. ICs applicable to the Site could include the following:

- Governmental Controls – Zoning restrictions/overlay districts/Special Planning Areas and building permit notices and restrictions that identify and restrict residential and commercial land uses in areas that could potentially pose an unacceptable risk to humans;

- Proprietary Controls – Environmental Covenant to identify and restrict residential and commercial land uses in areas that could potentially pose an unacceptable risk to humans;

- Enforcement Tools – CD/UAO requirements for development of an IC Plan for the Site and requiring monitoring and reporting of land uses and the effectiveness of the ICs; and CD/UAO requirements to identify restrictions on excavation and requirements for excavation in areas that could pose a potential risk to construction workers; and

- Information Devices - Deed notices identifying presence of contamination, restrictions on residential land use and requirements for performing soil excavation within the Site area; identification of the presence of contamination and associated excavation requirements by the UNCC; and identification of the presence of contamination and land use restrictions in the various CCoD comprehensive land-use plans, zoning ordinances and land development regulations.

The areas that would be subject to ICs are identified on Figure 9. Areas identified on Figure 9 for implementation of institutional controls include areas containing lead or arsenic at concentrations greater than the residential action levels (70 mg/kg for arsenic and 400 mg/kg for lead) for which restrictions on residential land use would be implemented. Figure 9 also identifies the areas outside of the footprint of existing buildings that contain lead above the commercial/industrial action level (800 mg/kg). These areas would be subject to restrictions requiring appropriate health and safety and materials management procedures for any excavations conducted in conjunction with subsurface infrastructure upgrades, repairs or replacements in areas of residual contamination. Figure 9 also identifies areas that are currently covered by structures that overlay areas containing lead above the action level. These areas would be subject to institutional controls that would require implementation of appropriate health and safety and materials management procedures in conjunction with any building demolition or redevelopment activities that may occur in the future in the areas of residual contamination. For alternatives that include containment or excavation (discussed below) institutional controls for these areas may also require implementation of remedial actions in conjunction with any future building demolition or redevelopment activities that may occur in these area.

4.2.3 Alternative 3 - Capping

Areas shown on Figure 10 coincide with soil sample locations where concentrations of lead in surface and subsurface soil within the "0 to 5 feet" depth interval exceeded the 800 mg/kg action level. Under Alternative 3, these areas would be capped to prevent exposure by commercial workers to shallow soils containing lead above the action level. Figure 10 was developed using the Thiessen polygon areas from Figure A-7.

As shown on Figure 10, the total area proposed for capping is approximately 21.8 acres. Of this total, the majority of the area (approximately 20.3 acres) is covered by existing concrete or asphalt-paved surfaces or buildings. For purposes of costing, it is assumed that the areas covered by existing concrete or asphalt-paved surfaces (approximately 14.6 acres) contain joints or cracks that would require sealing using a rubberized or polymer-modified asphaltic sealant to prevent the entry of surface water and subsequent freeze/thaw cycles that are the cause of cracking in asphalt-paved surfaces. Crack sealing would involve preparation of the crack for sealing by blowing out dust and foreign matter and drying the crack using a lance that emits hot compressed air followed by injection of the hot sealant. Following the crack sealing, it is assumed that these areas would undergo sealcoating with a coal tar or asphalt-based emulsion. Also, routine inspections and ongoing preventative maintenance activities (e.g., sealcoating with a coal tar or asphalt-based emulsion) would also be implemented for these areas at a frequency of every four years as a component of Alternative 3. It is further assumed that the surfaces area of those areas covered by existing concrete or asphalt-paved surfaces would require a resurfacing overlay after a period of 15 years. Resurfacing would involve preparation/cleaning of the area, application of a tack coat, installation of the hot asphalt overlay, and roller compaction.

For those areas shown on Figure 10 that are currently not covered by a paved surface (approximately 1.5 acres), Alternative 3 would include capping of these areas. For purposes of costing, it is assumed that the existing surface of the uncovered area would be excavated to a depth of approximately 8 inches and the cap materials would include an aggregate base course, an asphaltic binder course, and a topping. For purposes of preparing a cost estimate for Alternative 3, it is assumed that the excavated soil would be trucked to the Denver Arapahoe Disposal Site (DADS) permitted disposal facility in Arapahoe County, Colorado, approximately 23 miles from the Site.

Alternative 3 would also include the IC components described as part of Alternative 2.

4.2.4 Alternative 4 - Soil Excavation

Excavation of contaminated soil and subsequent offsite disposal, followed by backfilling of the excavation with clean soil could eliminate or reduce source mass and source area concentrations of contaminants of concern in soil. For purposes of preparing a cost estimate for this FS, areas that would be considered for excavation are shown on Figures 11A, 11B, and 11C for the “0 to 5 feet”, “5 to 10 feet”, and “10 feet and greater” depth intervals, respectively. These areas coincide with locations where soil samples contained concentrations of lead greater than 800 mg/kg.

The volume of soil containing lead at concentrations greater than the action level was estimated by depth layers. The “0 to 5 feet” and “5 to 10 feet” depth intervals were assigned a thickness of 5 feet. In the case of the interval “10 feet and greater”, a thickness of 20 feet was assigned.

Soil volumes within each layer were estimated using GIS software through development of Thiessen polygons around each soil sample and soil boring location. Thiessen polygons are polygons whose boundaries define the areas closest to each sample point relative to all other sample points. They are mathematically defined by the perpendicular bisectors of the lines between all points. The 22 Thiessen polygon areas used for estimation of the soil volumes where soil samples contained concentrations of lead greater than 800 mg/kg are shown on Figures A-7, A-8, and A-9 (Appendix A) for the “0 to 5 feet”, “5 to 10 feet”, and “10 feet and greater” depth intervals, respectively. A summary table of the soil volumes associated with each polygon is provided as the first sheet (Excavation Description) of the cost estimate for Alternative 4 in Appendix B.

In cases where areal samples of surface soil (as opposed to point location samples) had previously been collected, the areal extent of the surface soil samples was also considered. Areas associated with these samples are shown using a separate color on Figure A-7 in Appendix A. For areal surface soil samples that were above action levels and were located outside of Thiessen polygons containing point samples with arsenic or lead concentrations above action levels, the areas for the samples located outside of the Thiessen polygons were treated separately. For area samples that were included in or cut across Thiessen polygons, the Thiessen polygons were split by the areal surface sample areas and the remaining pieces of the polygons were merged back into one polygon to avoid double counting volumes.

The estimated volumes of soil containing lead at concentrations greater than 800 mg/kg are shown on as the first sheet (Excavation Description) of the cost estimate for Alternative 4 in Appendix B. The overall estimated total volume of soil containing lead at concentrations greater than the action level that would be excavated and disposed offsite under Alternative 4 is approximately 715,000 bank cubic yards (bcy). This volume includes approximately 342,000 bcy of soil that are currently accessible for excavation and 372,000 bcy of soil that are not immediately accessible for excavation due to the presence of existing buildings.

As shown on Figures 11A, 11B, and 11C, there are some areas where soils proposed for excavation are immediately accessible and other areas where the presence of buildings and other site structures currently limit access to the contaminated soil. It is assumed that, for those areas where the presence of buildings and other site structures currently limit access to the contaminated soil, excavation of soil in these areas would be implemented as part of future redevelopment of the property after the buildings and site structures located within the areal extent shown on Figures 11A, 11B, and 11C were demolished. Because of the nature of the soils at the Site, it is assumed that a 1:1 sideslope on all sides of the excavations would have to be maintained. This requirement would necessitate removal and on-site stockpiling of approximately 304,000 bank cubic yards of uncontaminated soil within the layback areas of the excavations. The potentially contaminated soil would be transported and disposed at DADS.

Prior to transporting soil to DADS for disposal, representative samples of excavated soil would be analyzed for Toxicity Characteristic Leaching Procedure (TCLP) arsenic and lead concentrations. If the results from the analyses indicate that the arsenic and lead levels are TCLP non-hazardous, then the soil would be directly disposed at DADS. However, if the analyses indicate that the soils would be TCLP hazardous, then the soils would be solidified/stabilized on-site to the extent that they are TCLP non-hazardous. Based on DADS experience with acceptance of soils contaminated with arsenic and lead from the Globeville Smelter site, for purposes of preparing a cost estimate for this Alternative 4, it is assumed that all excavated soils would be TCLP non-hazardous.

During excavation it is assumed that one sample would be collected for every approximate 100 cubic yards of suspected contaminated soil and analyzed for arsenic and/or lead. After suspected contaminated soil has been excavated to depths where historical investigatory soil samples indicate non-detect concentrations of contaminants, confirmatory samples would be collected from the excavation floor at a frequency of one sample every approximate 1,000 square feet and analyzed for arsenic and/or lead. Excavation would continue in approximate 6-inch lifts until excavation floor samples yield non-detect concentrations of arsenic and/or lead.

Following excavation, in addition to the stockpiled non-contaminated soil, approximately 888,000 loose cubic yards of clean fill would be trucked to the Site for backfill. The open excavations would be backfilled and compacted. For costing purposes, it is assumed that an asphalt cap would be placed over the excavation areas after the excavations are backfilled.

Other components of Alternative 4 that would be incorporated for costing purposes include preparation of site-specific planning documents (Work Plan, field procedures, construction and analytical QC components, traffic control, and health and safety) prior to excavation activities; mobilization/demobilization of construction equipment; site preparation including construction of a soil stockpile area and decontamination station (if necessary), construction of a solidification/stabilization treatment area (if necessary); and stormwater management activities during excavation operations. Health and safety measures would be implemented to protect on-site workers during excavation activities. For cost estimating purposes, modified Level D personal protective equipment (PPE) and decontamination equipment has been assumed. After completion of the excavation and disposal activities, a Construction Completion Report (CCR) would be prepared. The CCR would include site drawings, sampling results, copies of manifests, and a detailed narrative of the remedial action.

Alternative 4 would also include the IC components described as part of Alternative 2.

5 DETAILED ANALYSIS OF ALTERNATIVES

This section presents a detailed analysis of the four alternatives developed in Section 4. The purpose of this detailed analysis is to provide sufficient information to allow comparison of the alternatives based on the standard criteria specified in the NCP.

Detailed evaluation of the final alternatives for a remedial action is a two-stage process. The first stage of the evaluation involves assessing each of the alternatives with respect to nine individual criteria. The second stage of the evaluation process involves grouping of the criteria into a tiered system to reflect their interrelationships and different levels of significance. During the second-stage evaluation, the alternatives are initially evaluated according to the threshold criteria, which must be met, and then the alternatives are compared with each other to identify relative advantages and disadvantages among the different balancing criteria. The purpose of the comparative analysis is to provide information for a balanced remedy selection. The first-stage evaluation of the final remedial action alternatives for the FS is presented in this section and is based on the conceptual descriptions of the final alternatives provided in Section 4. The second-stage evaluation of final remedial action alternatives is presented in Section 6.

The NCP [40 CFR Section 300.430(e)(9)(iii)] categorizes the nine evaluation criteria into three groups: threshold criteria, primary balancing criteria, and modifying criteria. Each type of criteria has its own weight when it is evaluated. Threshold criteria are requirements that each alternative must meet to be eligible for selection as the preferred alternative, and include overall protection of human health and the environment and compliance with ARARs (unless a waiver is obtained).

The nine NCP evaluation criteria include:

Threshold Criteria:

- Overall Protection of Human Health and the Environment; and
- Compliance with ARARs.

Primary Balancing Criteria:

- Long-Term Effectiveness and Permanence;
- Reduction of Toxicity, Mobility, or Volume through Treatment;
- Short-Term Effectiveness;
- Implementability; and
- Cost.

Modifying Criteria:

- State Acceptance; and
- Community Acceptance.

Primary balancing criteria are used to weigh effectiveness and cost tradeoffs among alternatives. The primary balancing criteria represent the main technical criteria upon which the alternative evaluation is based. Modifying criteria include State acceptance and community acceptance, and may be used to modify aspects of the preferred alternative when preparing the proposed plan.

Modifying criteria are generally evaluated after public comment on the RI/FS and the Proposed Plan. Accordingly, only the seven threshold and primary balancing criteria are used in this detailed analysis phase. The following sections provide descriptions of the evaluation criteria and the items considered when assessing alternatives with respect to each criterion.

5.1 Description of Evaluation Criteria

The evaluation criteria are described in the following subsections.

5.1.1 Overall Protection of Human Health and the Environment

This evaluation criterion assesses how each alternative provides and maintains adequate protection of human health and the environment. Alternatives are assessed to determine whether they can adequately protect human health and the environment from unacceptable risks posed by chemical concentrations in various media (soil, soil vapor, surface water, and groundwater) present at the Site, in both the short and long term. This criterion is also used to evaluate how risks would be eliminated, reduced, or controlled through treatment, engineering, ICs, or other remedial activities. The considerations evaluated during the analysis of each alternative for overall protection of human health and the environment are presented in below:

Protection of human health:

- Likelihood that the alternative reduces risk to human health to below risk-based levels.

Protection of the environment:

- Likelihood that the alternative reduces the threat to unaffected groundwater by minimizing migration of chemicals. As discussed in the HHRA, there are no completed exposure pathways to groundwater for ecological receptors.

- Likelihood that the alternative would reduce the threat to ecological receptors and that implementation of the alternative would not eliminate the habitat of the receptor to be protected.

5.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

This evaluation criterion is used to evaluate if each alternative would attain federal and state ARARs, or whether invoking waivers to specific ARARs is adequately justified. Other information, such as advisories, criteria, or guidance, is considered where appropriate during the ARARs analysis. The considerations evaluated during the analysis of the ARARs applicable to each alternative are presented below. Potential action-, location-, and chemical-specific ARARs for the alternatives presented in this FS are identified in Table 1.

Chemical-specific ARARs:

- Likelihood that the alternative will achieve compliance with chemical-specific ARARs (e.g., MCLs) within a reasonable period of time.
- If it appears that compliance with chemical-specific ARARs will not be achieved, then evaluation of whether a waiver is appropriate.

Location-specific ARARs:

- Determination of whether any location-specific ARARs (e.g., whether facilities will be located in a floodplain and preservation of wetlands) apply to the alternative.
- Likelihood that the alternative will achieve compliance with the location-specific ARAR.
- Evaluation of whether a waiver is appropriate if the location-specific ARAR cannot be met.

Action-specific ARARs:

- Likelihood that the alternative will achieve compliance with action-specific ARARs (e.g., new source air emission rules).
- Evaluation of whether a waiver is appropriate if the action-specific ARAR cannot be met.

Other criteria and guidance:

- Likelihood that the alternative will achieve compliance with other criteria, such as risk-based criteria.

5.1.3 Long-Term Effectiveness and Permanence

This evaluation criterion addresses the long-term effectiveness and permanence of maintaining the protection of human health and the environment after implementing the remedial action imposed by the alternative. The primary components of this criterion are the magnitude of residual risk remaining at the Site after remedial objectives have been met and the extent and effectiveness of controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes. The considerations evaluated during the analysis of each alternative for long-term effectiveness and permanence are presented below. The components addressed for each alternative are described in more detail in the following subsections.

Magnitude of residual risks:

- Identity of remaining risks (risks from treatment residuals) as well as risks from untreated residual concentrations of contaminants.
- Magnitude of the remaining risks.

The magnitude of residual risk at the end of remedial activities is measured by numerical standards, or the volume or concentration of contaminants of concern remaining. The characteristics (volume, toxicity, and mobility) of the residuals remaining are also evaluated.

Adequacy and reliability of controls:

- Likelihood that the technologies will meet required process efficiencies or performance specifications.
- Type and degree of long-term management required.
- Long-term monitoring requirements.
- Operation and maintenance (O&M) functions that must be performed.
- Difficulties and uncertainties associated with long-term O&M functions.
- Potential need for technical components replacement.
- Magnitude of threats or risks should the remedial action need replacement.
- Degree of confidence that controls can adequately handle potential problems.
- Uncertainties associated with land disposal of residuals and untreated wastes.

The adequacy and reliability of controls that are used to either manage treatment residuals or untreated materials that remain after attaining numerical limitations are evaluated. This criterion includes an assessment of containment systems and ICs to evaluate the degree of confidence that they adequately handle potential problems and provide sufficient protection. The criterion also addresses long-term reliability, the need for long-term management and monitoring, and the potential need to replace technical components of the alternative.

5.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This evaluation criterion addresses the anticipated performance of the treatment technologies employed by each alternative in permanently and significantly reducing toxicity, mobility, and/or volume of contaminants of concern associated with the Site. The NCP prefers remedial actions where treatment is used to reduce the principal threats at a site through destruction of toxic chemicals, irreversible reduction in chemical mobility, or reduction of total volume of media containing concentrations of contaminants of concern. The considerations evaluated during the analysis of each alternative for reduction of toxicity, mobility, or volume of contaminants of concern present at a given site are presented below.

Treatment process and remedy:

- Likelihood that the treatment process addresses the principal threat.
- Special requirements for the treatment process.

Relative amount of hazardous material destroyed or treated:

- Portion (mass) of contaminant of concern that is destroyed.
- Portion (mass) of contaminant of concern that is treated.

Reduction in toxicity, mobility, or volume:

- Extent that the total mass of contaminants of concern is reduced.
- Extent that the mobility of contaminants of concern is reduced.
- Extent that the volume of contaminants of concern is reduced.

Irreversibility of treatment:

- Degree that the effects of the treatment are irreversible.

Type and quantity of residuals remaining following treatment:

- Residuals that will remain.
- Quantities and characteristics of the residuals.
- Risk posed by the treatment residuals.

Statutory preference for treatment as a principal element:

- Extent to which the scope of the action covers the principal threats.
- Extent to which the scope of the action reduces the inherent hazards posed by the principal threats at the Site.

5.1.5 Short-Term Effectiveness

Short-term effectiveness considers the effect of each remedial alternative on the protection of human health and the environment during the construction and implementation phase. The short-term effectiveness evaluation only addresses protection prior to meeting the RAOs. The considerations evaluated during the analysis of each alternative for short-term effectiveness are presented below.

Protection of the community during any remedial action:

- Risks to the community that must be addressed.
- How the risks will be addressed and mitigated.
- Remaining risks that cannot be readily controlled.

Protection of workers during remedial actions:

- Risks to the workers that must be addressed.
- How the risks will be addressed and mitigated and the effectiveness and reliability of measures to be taken.
- Remaining risks that cannot be readily controlled.

Environmental impacts of any remedial action:

- Environmental impacts that are expected with the construction and implementation of the alternative.
- Mitigation measures that are available and their reliability to minimize potential impacts.
- Impacts that cannot be avoided, should the alternative be implemented.

Time until RAOs are achieved:

- Time to achieve protection against the threats being addressed.
- Time until any remaining threats are addressed.
- Time until RAOs are achieved.

5.1.6 Implementability

Implementability evaluates the technical feasibility and administrative feasibility (i.e., the ease or difficulty) of implementing each alternative and the availability of required services and materials during its implementation. The following considerations are evaluated during the analysis of each alternative for implementability.

5.1.6.1 Technical Feasibility

Ability to construct and operate the technology:

- Difficulties associated with the construction.
- Uncertainties associated with the construction.

Reliability of the technology:

- Likelihood that technical problems will lead to schedule delays.

Ease of undertaking additional remedial action:

- Likely future remedial actions that may be anticipated.
- Difficulty implementing additional remedial actions.

Monitoring considerations with respect to effectiveness of the remedy:

- Migration or exposure pathways that cannot be monitored adequately.
- Risks of exposure, should the monitoring be insufficient to detect failure.

5.1.6.2 Administrative Feasibility

Coordination with other agencies:

- Steps required coordinating with regulatory agencies to implement any remedy.
- Steps required establishing long-term or future coordination among agencies.
- Ease of obtaining permits for off-property activities, if required.

5.1.6.3 Availability of Services and Materials

Availability of treatment, storage capacity, and disposal services:

- Availability of adequate treatment, storage capacity, and disposal services.
- Additional capacity that is necessary.
- Whether lack of capacity prevents implementation.
- Additional provisions required to ensure that additional capacity is available.

Availability of necessary equipment and specialists:

- Availability of adequate equipment and specialists.
- Additional equipment or specialists that is required.
- Whether there is a lack of equipment or specialists.
- Additional provisions required to ensure that equipment and specialists are available.

Availability of prospective technologies:

- Whether technologies under consideration are generally available and sufficiently demonstrated to be effective.
- Further field applications needed to demonstrate that the technologies may be used full-scale to treat contaminants of concern.
- When technology should be available for full-scale use.
- Whether more than one vendor will be available to provide a competitive bid.

5.1.7 Cost

The estimated costs are presented within the +50 percent/-30 percent accuracy range stated in RI/FS guidance (USEPA, 1988). Capital and operation, maintenance, and monitoring (OM&M) costs were prepared using March 2010 dollars. Estimates for professional/technical services cost elements (project management, remedial/corrective action design, construction management, and technical support) were based on the example percentages provided in Exhibit 5-8 in *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (USEPA, 2000b).

In preparing the capital and OM&M cost estimates, a contingency allowance of 25 percent was included to address unforeseen circumstances such as the ability to estimate the scope of any remedial alternative at this stage of the FS, the ability to predict the schedule for implementation of a remedy, and the ability to estimate costs associated with the various technologies considered in the alternatives. With respect to the present worth cost analyses, in accordance with current USEPA guidance (USEPA, 2000b), the 30-year Real Treasury Interest Rate for 2010 contained in the latest *Appendix C of OMB Circular 94 Guidelines and Discount Rates for Benefit-Cost Analysis* (OMB, 2010) of 2.7 percent (before taxes and after inflation) and a 30-year period of performance for costing purposes were assumed.

5.1.8 State Acceptance

This criterion involves technical and administrative concerns that the State may communicate in its comments concerning each alternative.

5.1.9 Community Acceptance

The preferred alternative(s) for this Site will be presented to the public in a Proposed Plan, which will provide a brief summary of all of the alternatives studied in the detailed analysis of the alternatives section of the FS (Section 5). In accordance with the NCP, the public will have an opportunity to review and comment on the selected remedial alternative(s) presented in the Proposed Plan. The public's comments will be addressed in the responsiveness summary and the ROD for the Site.

5.2 Results of the Detailed Analysis of Alternatives

The following sections present the detailed analysis of the four remedial alternatives using the seven threshold and primary balancing criteria.

5.2.1 Alternative 1 – No Action

No engineered measures, ICs, or monitoring would be implemented to reduce source area concentrations, prevent chemical migration, restrict or eliminate potential exposures to Site chemicals, or reduce exposure of chemical concentrations to potential human receptors. The No Action Alternative is required by the NCP to provide a baseline for evaluation/comparison of the costs and benefits of other alternatives.

5.2.1.1 Overall Protection of Human Health and Environment

Potential risks from exposure to soil are greater than levels for current and reasonably anticipated land use. Consequently, the No Action alternative does not eliminate, reduce, or control the pathway by which persons could potentially be exposed. As no actions would be taken to address RAOs for OU-2, this alternative would not be protective of human health and the environment.

5.2.1.2 Compliance with ARARs

The CSEV for lead of 800 mg/kg (worker scenario), a potential chemical-specific TBC, would not be met. Since there would be no active remediation measures included in the No Action alternative, location- and action-specific ARARs do not apply and state environmental covenants law would not be met.

5.2.1.3 Long-Term Effectiveness and Permanence

The No Action alternative would not be effective in the long term because all current and potential future risks would remain. Under the No Action alternative, risks posed by contaminant of concern occurrences in soil would remain unchanged.

5.2.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

There would be no reduction in toxicity, mobility, and volume through treatment under the No Action alternative because no treatment technologies would be employed. Therefore, the No Action alternative would not address the statutory preference for treatment as a principal element. No treatment residuals would be generated.

5.2.1.5 Short-Term Effectiveness

Because no remedial action would be taken under the No Action alternative, no short-term risks to the community or to workers as a result of implementing the alternative would occur. Similarly, no environmental impact from construction activities would occur.

The RAOs of (1) limiting exposure of commercial and construction workers to lead in commercial exposure unit C-2, and (2) limiting or preventing exposure of potential future residential users to lead in residential exposure units R-1, R-2, and R-3 (all areas of the Operable Unit except the south half of the Denver Coliseum parking lot); and metals in residential exposure unit R-2 would not be met under the No Action alternative.

5.2.1.6 Implementability

As no active or passive remedial technologies would be implemented under the No Action alternative, there are no technical or administrative implementability concerns or issues associated with the No Action alternative. There would be no impediments to implementing the No Action alternative.

5.2.1.7 Costs

No costs are associated with the No Action alternative, as no remedial actions would be conducted.

5.2.2 Alternative 2 – Institutional Controls

ICs would be developed, applied, and maintained under Alternative 2. The objectives of the ICs to be developed and implemented under this alternative are expected to include the following:

- Prevent residential land use by restricting land uses to commercial or industrial uses in areas where residual contamination will remain in place at concentrations that are above the levels that would allow for unrestricted use;

- Require appropriate health and safety and materials management procedures for any excavations conducted in conjunction with subsurface infrastructure upgrades, repairs or replacements in areas of residual contamination; and

- Require implementation of appropriate remedial actions in conjunction with any building demolition or redevelopment activities that may occur in the future in the areas of residual contamination.

The specific mechanisms under which the ICs would be developed and enforced were previously discussed in Section 4.2.2.

5.2.2.1 Overall Protection of Human Health and Environment

Under Alternative 2 (ICs), the risks would be reduced and controlled through implementation, monitoring, and enforcement of ICs that would only allow land uses compatible with the presence of the types of residual contaminants of concern in soil and would restrict use of the land that could result in exposure to residual contaminants of concern at levels that could pose an unacceptable risk.

Assuming the implementation, monitoring, and enforcement of ICs, Alternative 2 would be protective of human health and the environment. As Alternative 2 relies on ICs to achieve the additional protectiveness, it is not considered to meet the NCP expectation of relying on engineered measures to reduce or eliminate potential risks, unless the ICs included requirements for engineered measures (e.g., capping).

5.2.2.2 Compliance with ARARs

Potential applicable or relevant and appropriate chemical-specific ARARs would include the National Ambient Air Quality Standards (NAAQS) and the Colorado Air Pollution Prevention and Control Act; however since Alternative 2 would not involve construction activities, they would be neither applicable nor relevant and appropriate. The CSEV for lead of 800 mg/kg (worker scenario) potential chemical-specific TBC would not be met. Since Alternative 2 only consists of implementation of ICs, none of the potential location-specific ARARs would apply. ICs would be developed in accordance with the requirements of the portions of the Colorado hazardous waste regulations that are pertinent to environmental covenants.

5.2.2.3 Long-Term Effectiveness and Permanence

The primary components of this criterion are the magnitude of residual risk remaining at the Site after remedial objectives have been met and the extent and effectiveness of controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes.

Magnitude of residual risk. While the concentrations of contaminants of concern in soil would not be reduced by implementing, monitoring, and enforcement of ICs, risk would be reduced by restricting or controlling the land use. As this alternative relies solely on implementation, monitoring, maintaining and enforcement of ICs to ensure that unacceptable risks do not occur, it does not meet USEPA program expectations of using treatment or engineering controls to address contamination or EPA's expectation that use of ICs shall not substitute for active response measures (40 CFR 300.430 (a)(1)(iii). EPA does not consider ICs to be as effective or permanent as alternatives that utilize treatment or engineered measures to insure protectiveness (EPA, 1997a).

Adequacy and reliability of controls. Assuming implementation, monitoring, and enforcement of ICs, it is highly likely that Alternative 2 (ICs) would meet process effectiveness and permanence.

5.2.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

There would be no reduction in the toxicity, mobility or volume through treatment under Alternative 2 as no treatment technologies would be employed. Therefore, no treatment residuals would be generated and the alternative would not address the statutory preference for treatment as a principal element

5.2.2.5 Short-Term Effectiveness

As there would be no active remediation measures included in Alternative 2, it would not pose any unacceptable short-term risks or other adverse environmental impacts. Because no remedial action would be taken other than implementation of additional ICs, no short-term risks to the community or to workers from implementation of this action would occur. Similarly, no environmental impact from construction activities would occur.

Implementation, monitoring, and enforcement of ICs limiting the properties in OU-2 to land uses that would not result in exposure to contaminants of concern at concentrations greater than action levels would insure that the RAOs of (1) limiting exposure of commercial and construction workers to lead in commercial exposure unit C-2, and (2) limiting or preventing exposure of potential future residential users to lead in residential exposure units R-1, R-2, and R-3 (all areas of the Operable Unit except the south half of the Denver Coliseum parking lot); and metals in residential exposure unit R-2 would be met.

With respect to the time until response objectives would be achieved, it is estimated that it would take approximately one year to prepare the IC plan and to develop and implement the ICs under Alternative 2.

5.2.2.6 Implementability

Technically, Alternative 2 (ICs) would be easily implemented. There are no technical difficulties associated with implementing ICs. As CCoD has been the only owner of property located within OU-2 that has participated in the development of the RI/FS, it is envisioned that the owners of other properties within OU-2 may not understand or agree with the need for implementation of ICs. This could present an administrative issue for implementation of ICs. Specifically, implementation of governmental controls such as zoning restrictions or proprietary controls such as environmental covenants or environmental easements without the consent of the various property owners may be difficult and could represent a potential "taking" of private property rights. Until discussions are held with the various property owners, the potential implementability of these types of ICs cannot be fully assessed. Implementation of enforcement tools would be the responsibility of USEPA and therefore the implementability of this type of IC is subject to USEPA's discretion. Some information devices such as deed restrictions are also subject to consent by the property owner; however, others such as inclusion of a general notification in the comprehensive land use plans for the area can be implemented by CCoD in accordance with CCoD zoning and land development regulations."

The technical and legal professionals are readily available to design, implement and monitor the performance of the ICs.

5.2.2.7 Costs

Estimated capital, annual OM&M, and 30-year present worth costs for Alternative 2 (ICs) are as follows:

Capital costs:	$31,000
Annual OM&M costs:	$2,000 per year
30-year Present Worth costs:	$70,000

Detailed estimates are included in Appendix B. A summary of the cost estimates for all of the alternatives is provided in Table 2.

5.2.3 Alternative 3 - Capping

Areas shown on Figure 10 that coincide with soil sample locations where concentrations of lead in surface and subsurface soil within the "0 to 5 feet" depth interval exceed the 800 mg/kg action level would be capped. The majority of the area is covered by existing paved surfaces or buildings. For this alternative, it is assumed that cracks exist in these paved surfaces and the cracks would be sealed. Following the crack sealing, the areas would be sealcoated at a frequency of every five years and a resurfacing overlay would be placed after a period of 15 years. Also, asphalt pavement or other form of surface cap would be placed over those areas that are currently not covered by a paved surface. In addition, Alternative 3 would include the IC components described as part of Alternative 2.

5.2.3.1 Overall Protection of Human Health and Environment

Sealing of cracks, applying sealcoat, and overlay resurfacing on existing paved surfaces and installing an asphalt paving cap over those areas that are currently not covered by a paved surface would eliminate the potential for direct contact with surface and subsurface soil containing contaminants of concern above action levels. Maintenance of existing paved surfaces and installation and maintenance of a new cap would also eliminate any potential for windblown dust containing contaminants of concern. Therefore, the capping alternative would be protective of human health. The presumption under Alternative 3 is that all buildings would remain in-place. In the event that a building were to be removed, the ICs component of this alternative would require implementation of appropriate remedial actions in conjunction with building demolition in the areas of residual contamination (see Section 4.2.2).

Alternative 3 would meet the NCP expectation of relying on engineered measures to reduce or eliminate potential risks. These engineered measures would be augmented through the implementation, monitoring, and enforcement of existing and additional new ICs that would only allow land uses compatible with the presence of the types of residual contaminants of concern in soil and would restrict use of the land that could result in exposure to residual contaminants of concern at levels that could pose an unacceptable risk.

5.2.3.2 Compliance with ARARs

Potential applicable or relevant and appropriate chemical-specific ARARs would include the National Ambient Air Quality Standards (NAAQS) and the Colorado Air Pollution Prevention and Control Act for fugitive dust emissions associated with earth-moving activities during construction. As no fugitive dust emissions are expected during construction of the capping materials, Alternative 3 would comply with chemical-specific ARARs. While not a chemical-specific ARAR, Alternative 3 would comply with the CSEV for lead of 800 mg/kg (worker scenario) potential TBC criterion. ICs would be developed in accordance with the requirements of the portions of the Colorado hazardous waste regulations that are pertinent to environmental covenants.

No specific potential location-specific ARARs that may apply to this alternative were identified.

Potential action-specific ARARs would include the Colorado Diesel-Powered Vehicle Emissions Standards for Visible Pollutants for diesel-powered motor vehicles associated with paving equipment and the Colorado Noise Abatement Statute for allowable decibel levels during certain time periods. It is expected that equipment and vehicles used during paving activities would comply with these action-specific ARARs.

5.2.3.3 Long-Term Effectiveness and Permanence

<u>Magnitude of residual risk</u>. Under this Alternative, soil containing metals would remain, and therefore residual risk would remain; however, existing capping surfaces would be sealed and an asphalt paving cap would be constructed over those areas that are currently not covered by a paved surface to prevent exposures to the contaminants of concern in shallow soil. While the concentrations of contaminants of concern in soil would not be reduced, the presence of capped surfaces combined with implementation, monitoring, and enforcement of existing and additional ICs to control land uses would prevent exposure and reduce risk. Implementation of additional ICs would assure that no changes in existing land uses occur and that only those land uses that would not pose a potential risk would occur in the future.

Adequacy and reliability of controls. The presence of both capping combined with ICs should provide an adequate and reliable means of preventing exposure to contaminants of concern. Combining capping with ICs that control land uses should provide overlapping and redundant methods of protection. Long-term protection would be further assured through ongoing monitoring and maintenance of the presence and performance of the capping and the effectiveness of the ICs.

As this alternative relies on both capping and implementation, monitoring, and enforcement of ICs to insure that unacceptable risks do not occur, it is considered to be effective and permanent. Permanence of this alternative would be improved with regular cap inspection and maintenance, implementation of additional ICs restricting allowable uses and activities in OU-2, as well as monitoring and enforcement of the existing and additional ICs.

5.2.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

There would be no reduction in the toxicity, mobility or volume through treatment under Alternative 3 as no treatment technologies would be employed. Therefore, no treatment residuals would be generated and the alternative would not address the statutory preference for treatment as a principal element

5.2.3.5 Short-Term Effectiveness

As the only active remediation measures included in Alternative 3 are crack sealing, sealcoating, and asphalt paving, this alternative does not pose any unacceptable short-term risks or other adverse impacts. No short-term risks to the community, to workers, or to the environment from implementation of this action are expected to occur. Workers would be adequately protected during construction by adhering to Occupational Safety and Health Administration (OSHA) practices and proper health and safety measures.

Capping of areas where concentrations of lead in surface and subsurface soil within the "0 to 5 feet" depth interval exceed the 800 mg/kg action levels would insure that the RAOs of limiting exposure of commercial and construction workers to lead in commercial exposure unit C-2 are met. This goal would be met immediately upon completion of crack sealing/sealcoating in the existing paved areas and installation of asphalt paving or other form of capping in the currently unpaved areas containing lead concentrations above the cleanup level is completed. Implementation of institutional controls to restrict potential future residential use in residential exposure units R-1, R-2, and R-3 (all areas of the Operable Unit except the south half of the Denver Coliseum parking lot); and metals in residential exposure unit R-2 would meet the RAO of limiting or preventing exposure of residential users to lead and trace metals. This goal would be achieved upon implementation of the institutional controls.

With respect to the time until response objectives would be achieved, it is estimated that it would take approximately one year to prepare the various planning documents and remedial design, put-into-place the new ICs, and implement the crack sealing, sealcoating, and asphalt paving components of Alternative 3.

5.2.3.6 Implementability

Construction and maintenance of asphalt caps and development and application of ICs is technically feasible. Construction of asphalt cap components and maintenance of existing asphalt caps over areas where contaminants of concern are present in shallow soil can easily be performed using standard construction equipment and labor. The necessary materials and specialist personnel are easily attainable.

With the possible exception of asphalt paving in the currently unpaved areas on property not owned by the CCoD, there should be no administrative restrictions on implementation of Alternative 3.

Implementability issues associated with the ICs component of this alternative are discussed in Section 5.2.2.6.

5.2.3.7 Costs

Estimated capital, annual OM&M, and 30-year present worth costs for Alternative 3 (Capping) are as follows:

Capital costs:	$743,000
Annual OM&M costs:	$2,000 – 310,000 per year
30-year Present Worth costs:	$1,590,000

Detailed estimates are included in Appendix B. A summary of the cost estimates for all of the alternatives is provided in Table 2.

5.2.4 Alternative 4 – Excavation/Disposal of Soil

Alternative 4 would involve the excavation and subsequent disposal of contaminated soil containing lead at concentrations greater than 800 mg/kg. This volume of soil is estimated to be approximately 715,000 bank cubic yards (bcy). As shown on Figures 11A, 11B, and 11C, there are some areas where soils proposed for excavation are immediately accessible and other areas where the presence of buildings and other site structures currently limit access to the contaminated soil. For those areas where access is currently limited, excavation of soil would be implemented as part of future redevelopment of the property after the buildings and site structures were demolished.

Because of the nature of the soils at the Site, it is assumed that a 1:1 sideslope on all sides of the excavations would have to be maintained, necessitating removal and on-site stockpiling of approximately 304,000 bcy of uncontaminated soil within the layback areas of the excavations. The results of samples of excavated soil and the excavation floor would define the limits of excavation during construction. Potentially contaminated soil would be trucked to the Denver-Arapaho Disposal Site (DADS) permitted solid waste disposal facility in Arapahoe County, Colorado. Following excavation, in addition to the stockpiled non-contaminated soil, approximately 888,000 loose cubic yards (lcy) of clean fill would need to be trucked to the Site for backfill. The open excavations would be backfilled and compacted. It is assumed that an asphalt cap would be placed over the excavation areas after the excavations are backfilled.

Alternative 4 would also include the IC components for restriction of residential land use as described as part of Alternative 2. For areas where the soil containing lead at concentrations above the action levels has been removed, ICs related to soil excavation and management would not be required under this alternative.

5.2.4.1 Overall Protection of Human Health and Environment

Alternative 4 involves the removal of contaminated soil for those areas that are not currently covered by buildings and other structures and would allow for unrestricted use in these areas, therefore providing protection of human health by eliminating exposure by commercial/construction workers to soil contaminated at concentrations above risk-based levels for these types of exposures. For those areas where contaminants of concern would remain in-place in soil under some buildings and other structures until such time as these areas are redeveloped, ICs to restrict residential land use, and ICs requiring appropriate health and safety and materials management procedures to be implemented in conjunction with any future excavations or construction and requiring excavation and offsite disposal of soil above actions levels as part of any future building demolition or redevelopment activities would still be required. Consequently, the potential risks from soil would not be entirely eliminated under this alternative. Therefore, this alternative would also include the ICs described under Alternative 2 so that the remaining risks would be controlled through the implementation, monitoring, and enforcement of existing and additional new ICs that would only allow land uses that are consistent with the potential risks posed. Excavation/disposal of soil augmented with ICs would be protective of human health.

The excavation and off-site disposal of contaminated soils under Alternative 4 would also meet the NCP expectation of relying on engineered measures to reduce or eliminate potential risks.

5.2.4.2 Compliance with ARARs

Potential applicable or relevant and appropriate chemical-specific ARARs would include the NAAQS and the Colorado Air Pollution Prevention and Control Act for fugitive dust emissions associated with earth-moving activities during construction. Compliance with applicable provisions of these air quality requirements would be achieved by adhering to a Fugitive Emissions Dust Control Plan, which would discuss any monitoring requirements necessary to achieve the standards. Therefore, it is expected that Alternative 4 would comply with chemical-specific ARARs. While not a chemical-specific ARAR, Alternative 3 would comply with the CSEV for lead of 800 mg/kg (worker scenario) potential TBC criterion. ICs would be developed in accordance with the requirements of the portions of the Colorado hazardous waste regulations that are pertinent to environmental covenants.

No specific potential location-specific ARARs that may apply to this alternative were identified.

Potential action-specific ARARs would include:

- The federal Criteria for Classification of Solid Waste and Disposal Facilities and Practices in 40 CFR Part 257 establishes criteria for use in determining solid wastes and disposal requirements and would be potentially applicable since excavated soil would be a solid waste.

- The federal Criteria for Classification of Hazardous Waste and Disposal Facilities and Practices in 40 CFR Part 264 establishes criteria for use in determining hazardous wastes and disposal requirements. Excavated soil would be classified as D004 hazardous waste if the arsenic concentration from the TCLP test was greater than 5.0 mg/L. Excavated soil would be classified as D008 hazardous waste if the lead concentration from the TCLP test was greater than 5.0 mg/L.

- NAAQS fugitive dust emissions for particulates and lead associated with earth moving activities during construction would be potentially relevant and appropriate.

- Colorado Hazardous and Solid Waste regulations for solid waste determination, solid waste classification, and determination of hazardous waste.

- Colorado Air Emission Control regulations for particulate emissions during excavation and backfill, emission of hazardous air pollutants, air emissions from diesel-powered vehicles associated with excavation and backfill operations, odor emissions, smoke and opacity, and Ambient Air Standards for total suspended particulate matter and lead.

- Colorado Noise Abatement Statute for allowable decibel levels during certain time periods.

As discussed in Section 4.4, representative samples of excavated soil would be analyzed for TCLP arsenic and lead concentrations and soil would be classified and disposed in accordance with 40 CFR 257 and 264 and 6 CCR 1007-3. It is expected that equipment and vehicles used during soil excavation/transportation/disposal and on-site paving activities would comply with the NAAQS, Colorado Air Emission Control regulations for particulate emissions, and Colorado Noise Abatement Statute for allowable decibel levels action-specific ARARs.

5.2.4.3 Long-Term Effectiveness and Permanence

The long-term effectiveness of Alternative 4 would be increased if soil containing lead and arsenic at concentrations greater than the risk-based (action) levels for construction/commercial work exposures are removed from the Site. As discussed above, the presence of existing buildings currently limit access to the contaminated soil and would limit the ability to completely remove all of the contaminated soil until the buildings were demolished as part of future redevelopment of the property. Institutional controls would be used to control land uses until such time as redevelopment allows for removal of the remaining contaminated soil. In addition, this alternative would not remove all of the soil necessary for unrestricted use of the Site and therefore, ICs to restrict residential use of the Site would still be required.

Magnitude of residual risk. The majority of soil containing metals would be excavated and disposed off site. However, due to the presence of existing buildings, some contaminated soil cannot be removed and therefore residual risk would remain until such time as the buildings in these areas are removed prior to any redevelopment.

Adequacy and reliability of controls. Excavation and off-site disposal provides a permanent means of eliminating risks such that long-term management and monitoring is not required. For areas where soil removal cannot be immediately conducted, long-term protection would be assured through the ICs component of Alternative 4.

5.2.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Excavation and disposal is the USEPA Presumptive Remedy for soils containing metals. This technology would permanently remove the contaminants of concern, thereby reducing toxicity, mobility, and volume. As the excavated soil would be disposed in an off-site, permitted disposal facility, no treatment residuals would remain from excavation.

Prior to transporting soil for off-site disposal under Alternative 4, samples of excavated soil would be analyzed for TCLP arsenic and lead concentrations. It is assumed that all excavated soils would be TCLP non-hazardous. However, if the analyses indicate that the soils would be TCLP hazardous, then the soils would be solidified/stabilized on-site prior to off-site disposal. In this case, the toxicity and mobility of arsenic and lead in the soil would be reduced. No treatment residuals would be generated, as the solidification/stabilization reagent would be mixed with the soil into one matrix.

5.2.4.5 Short-Term Effectiveness

The active remediation measures comprising Alternative 4 would include excavation of contaminated soil, transportation of soil to a permitted disposal facility, backfilling of the excavations, and placing an asphalt cap over the surface of the excavated area. Construction of these remedy components would pose minimal short-term risks to workers or the community. Workers would be adequately protected during construction by adhering to OSHA practices and proper health and safety measures. Similarly, no environmental impact from construction activities is expected to occur.

Excavation (and subsequent offsite disposal) of soil in areas where concentrations of arsenic and lead in surface and subsurface soil exceed the 70 mg/kg and/or 800 mg/kg action levels would insure that the RAOs of limiting exposure of commercial and construction workers to lead in commercial exposure unit C-2. Implementation of ICs to restrict residential use at the Site would limit or prevent exposure of potential future residential users to lead in residential exposure units R-1, R-2, and R-3 (all areas of the Operable Unit except the south half of the Denver Coliseum parking lot); and arsenic and metals in residential exposure unit R-2.

The IC component of Alternative 4 (e.g., limiting the properties in OU-2 to land uses that would not result in exposure to chemicals at concentrations greater than risk-based levels) would further augment the effectiveness of the soil excavation/disposal component of Alternative 4.

With respect to the time until response objectives would be achieved, it is estimated that it would take approximately one to two years to prepare the various planning documents and remedial design, put-into-place the new ICs, and implement the soil excavation/disposal, backfilling, and asphalt paving over excavated areas components of Alternative 4.

5.2.4.6 Implementability

Excavation and off-site disposal of contaminated soil and development and application of ICs are technically feasible and would be easily implemented. Soil excavation, transport of soil, disposal of soil in a permitted landfill, backfilling, and asphalt paving are commercially available, demonstrated technologies that use standard construction equipment and labor. The necessary materials and specialist personnel are easily attainable. With the exception of contaminated soil located under existing buildings, Alternative 4 would be easily implemented from the technical perspective. The presence of existing buildings currently limits immediate access to some of the contaminated soil and would limit the ability to completely remove all of the contaminated soil until the buildings were demolished as part of future redevelopment of the property.

With the possible exception of excavation of soil on property not owned by the CCoD, there should be no administrative restrictions on implementation of Alternative 4.

Implementability issues associated with the ICs component of this alternative are discussed in Section 5.2.2.6.

5.2.4.7 Costs

Estimated capital, annual OM&M, and 30-year present worth costs for Alternative 4 (Excavation/Disposal of Soil) are as follows:

Capital costs:	
Initial Capital Cost	$21,633,000
Future Capital Cost (year 20)	$24,000,000
Annual OM&M costs:	$2,000 per year (through year 20)
30-year Present Worth costs:	$35,750,000

Detailed estimates are included in Appendix B. A summary of the cost estimates for all of the alternatives is provided in Table 2.

5.3 Summary of the Detailed Analysis of Alternatives

The detailed analysis of the four remedial alternatives is summarized on Table 3. The performance of each alternative relative to the threshold criteria (overall protection of human health and the environment and compliance with ARARs) and the primary balancing criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost) is provided.

6 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section presents the comparative analysis for the alternatives evaluated in Section 5. The relative performance of each alternative is evaluated against the performance of the other alternatives for each of the threshold and primary balancing criteria. This comparative analysis identifies the advantages and disadvantages of each alternative to assist in the decision making process leading to the Proposed Plan. A graphical comparison of the alternatives is provided on Figure 12.

6.1 Threshold Criteria

Two of the nine criteria specified in the NCP relate directly to statutory findings that must ultimately be made in the ROD. These two criteria are (1) overall protection of human health and the environment, and (2) compliance with ARARs. They are classified as threshold criteria, as the selected alternative must meet these two criteria.

6.1.1 Overall Protection of Human Health and the Environment

With the exception of the No Action alternative, the alternatives described in Section 4 and evaluated in Section 5 are anticipated to be protective of human health. Worker exposures will be eliminated or reduced through implementation of ICs under Alternative 2 and through implementation of a combination of engineering components and ICs under Alternatives 3 and 4.

6.1.2 Compliance with ARARs

As there are no chemical-specific ARARs relative to occurrences of lead and arsenic in soil, all four alternatives are anticipated to comply with chemical-specific ARARs. Similarly, as no location-specific ARARs were identified for the Site, all four alternatives are anticipated to comply with potential location-specific ARARs. Development and implementation of ICs will be performed to meet the requirements of the Colorado Revised Statutes (Article 15 of Title 25 Part 3 [25-15-301 et seq. CRS]) the components of the alternatives related to ICs are expected to meet action-specific requirements. No additional action-specific requirements were identified for capping (Alternative 3). Excavation and offsite disposal of contaminated soil (Alternative 4) would be performed in conformance with Colorado Air Quality, Solid Waste and Hazardous Waste regulations and therefore is expected to comply with action-specific requirements.

6.2 Primary Balancing Criteria

Alternatives 2, 3, and 4 are comparatively analyzed in this section for the next five of the nine criteria, the primary balancing criteria. (Alternative 1, the No Action alternative, is not evaluated with respect to the primary balancing criteria, as it did not meet the initial threshold criteria.) The five primary balancing criteria are:

- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility and volume through treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

These five criteria are collectively described as the primary balancing criteria as they provide the primary basis for differentiation among the various alternatives.

6.2.1 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence is a measure of the following two principal factors:

- Magnitude of residual risk; and
- Adequacy and reliability of controls.

6.2.1.1 Magnitude of Residual Risk

While the concentrations of contaminants of concern in soil would not be reduced through implementation, monitoring, and enforcement of ICs under Alternative 2; risk of exposure would be reduced by restricting or controlling the land use. As Alternative 2 relies solely on implementation, monitoring, and enforcement of ICs, the magnitude of residual risk posed by the Site would remain unchanged.

Under Alternative 3 (Capping), soil containing metals would remain, and therefore residual risk would remain. However, cracks in existing capped areas would be sealed/sealcoated and uncapped areas where contaminants are present in shallow soils would receive an asphalt cap to prevent exposures to the contaminants of concern. The presence of caps combined with implementation, monitoring, and enforcement of additional ICs to control land uses would prevent exposure and reduce risk. Implementation of additional ICs would ensure that no changes in existing land uses occur and that only those land uses that would be compatible with the potential risk would occur in the future.

Soil containing arsenic and lead would be excavated and disposed off site under Alternative 4 (Excavation/Disposal of Soil), thereby permanently eliminating or greatly reducing the potential risks. However, due to the presence of existing buildings, some soil containing contaminants of concern cannot be immediately removed and therefore residual risk would remain until such time as the buildings are removed prior to redevelopment. Institutional controls would be used to control land uses until such time as redevelopment allows for removal of the remaining contaminated soil.

6.2.1.2 Adequacy and Reliability of Controls

Alternatives 2, 3, and 4 would all include ICs. USEPA has not generally considered ICs to be as effective or permanent as alternatives that utilize engineered measures to insure protectiveness.

Combining capping with ICs that control land uses under Alternative 3 would provide overlapping and redundant methods of protection. Long-term protection would be further ensured through ongoing monitoring and maintenance of the presence and performance of the capped areas and the effectiveness of the ICs. Excavation and off-site disposal under Alternative 4 would provide a permanent means of eliminating risks posed by potential exposure by commercial or construction workers to contaminated soil. All three alternatives would rely on ICs to restrict residential land use and thereby protect against potential future exposures associated with possible residential use of the Site.

Assuming implementation, monitoring, and enforcement of additional ICs, Alternative 2 would meet process effectiveness and permanence. Alternative 3 would rely on both capping and ICs to insure that unacceptable risks do not occur and would therefore considered to be more effective and permanent than Alternative 2. Since Alternative 4 would include a mass removal component, it would appear to provide greater long-term effectiveness and permanence than Alternatives 2 and 3.

6.2.2 Reduction in Toxicity, Mobility, or Volume through Treatment

This criterion is a measure of the following five principal factors:

- Statutory preference for treatment as a principal element;
- Irreversibility of treatment;
- Type and quantity of treatment residual;
- Amount of hazardous material destroyed or treated; and
- Reduction in toxicity, mobility, or volume.

Since soil would remain in-place under Alternatives 2 and 3, they would not provide any reduction in toxicity. There would also be no reduction in toxicity or volume through treatment under Alternative 3. However, the presence of capping under Alternative 3 would reduce the mobility of contaminants of concern. As there would be no reduction in the toxicity, mobility, or volume through treatment under Alternatives 2 and 3, then no treatment residuals would be generated.

With respect to Alternative 4, excavation and disposal is the USEPA's Presumptive Remedy for soils containing metals. Although excavation and disposal of soil would not reduce the toxicity, mobility, or volume of the metals in soils through treatment, this technology would permanently remove the contaminants of concern, thereby reducing toxicity, mobility, and volume. As the excavated materials would be disposed of in an off-site, permitted disposal facility, excavation would not result in treatment residuals.

6.2.3 Short-Term Effectiveness

Short-term effectiveness is a measure of the protection afforded by each alternative during the construction and implementation process. As such, the time until RAOs are achieved is an important component of this criterion. The availability of equipment and specialists to implement the alternative is also a consideration. This criterion is a measure of the following three principal factors:

- Protection of workers and the community during the remedial action;
- Environmental impacts; and
- Time until remedial response objectives are achieved.

Because no remedial action other than implementation of ICs would be taken under Alternative 2, no short-term risks to the community or to workers from implementation of this action would occur. Similarly, no environmental impact from construction activities would occur.

Construction and maintenance of the capping technology under Alternative 3 and excavation of soil under Alternative 4 would pose minimal short-term risks to workers and/or the community. Standard OSHA precautions necessary to protect worker safety during construction would be employed. No environmental impact from construction activities is expected to occur.

Implementation, monitoring, and enforcement of ICs limiting properties to land uses that would not result in exposure to contaminants at concentrations greater than risk-based levels (Alternatives 2, 3, and 4) would insure that the RAOs of (1) limiting exposure of commercial and construction workers to lead in commercial exposure unit C-2, and (2) limiting or preventing exposure of potential future residential users to lead in residential exposure units R-1, R-2, and R-3 (all areas of the Operable Unit except the south half of the Denver Coliseum parking lot); and metals in residential exposure unit R-2 would be met.

With respect to the time until response objectives would be achieved, it is estimated that it would take approximately one-year to prepare the IC plan and to develop and implement additional ICs (Alternative 2); approximately one year to prepare the various planning and remedial design documents and implement the crack sealing, sealcoating, and asphalt paving components of Alternative 3; and approximately one to two years to implement the soil excavation/disposal components of Alternative 4. The ICs component of Alternatives 3 and 4 would be planned, developed, and implemented concurrently with the other components of these alternatives.

6.2.4 Implementability

Implementability evaluates the technical and administrative difficulties associated with implementing each alternative. Each of the alternatives is implementable to varying degrees, but there are several technical and administrative difficulties associated with each of the alternatives evaluated in this FS.

Technically, Institutional Controls (Alternative 2) would be easily implemented, as would the ICs component of Alternatives 3 and 4. There are no technical difficulties associated with implementing additional ICs as no physical facilities would be constructed. Implementation of additional ICs will involve coordination with regulatory agencies, governmental entities, and landowners within OU-2. The technical and legal professionals are readily available to develop the documents and implement additional ICs.

From an administrative implementability perspective, there are several areas within the Site where existing buildings or structures will remain in service or will not be demolished until future development plans are implemented. Their presence will prevent the implementation of capping (Alternative 3) and excavation/disposal of soil (Alternative 4) in some areas for several years.

With respect to capping (Alternative 3), sealing cracks within an existing asphalt cap, construction of a new asphalt cap, and maintenance of existing asphalt over areas having arsenic and lead in soil can easily be performed and is technically feasible. The technology is commercially available and uses standard construction equipment and labor. The necessary materials and specialist personnel are easily attainable. There should be no administrative restrictions on implementation of capping under Alternative 3 other than coordination with the non-CCoD property owners within OU-2.

Excavation and off-site disposal of soil under Alternative 4 is technically feasible. Alternative 4 would present few administrative difficulties other than coordination with property owners within OU-2 other than the CCoD. Excavation and off-site disposal in a permitted landfill is a commercially available demonstrated technology that involves the use of standard construction equipment and labor. The necessary materials and equipment are easily attainable and specialist personnel are readily available.

In summary, from both the administrative and technical perspectives, Alternative 2 (Institutional Controls) would be the easiest to implement, followed by Alternative 3

(Capping). Alternative 4 (Excavation/Disposal of Soils) would be the most difficult to implement.

6.2.5 Cost

A summary of the estimated costs associated with each alternative was presented previously in Table 2. The cost estimates for each alternative were prepared in accordance with current USEPA guidance with respect to level of accuracy and discount rate (i.e., 2.7 percent). For comparison purposes, the estimated total capital cost, estimated annual O&M costs, and estimated 30-year present worth cost estimates are presented in Table 2 for each of the alternatives. The basis for the costs and the methodology and information used to develop the costs are provided in Appendix B.

The 30-year present worth cost for Alternative 2 (Institutional Controls) is significantly less than the other two alternatives. Capital and present worth cost estimates for excavation and disposal of contaminated soil under Alternative 4 are approximately twenty times higher than those for Alternative 3 (Capping).

6.3 Modifying Criteria

The final two of the nine criteria are state acceptance and community acceptance. These two criteria are evaluated following comment on the FS and Proposed Plan and as such are termed modifying criteria.

6.3.1 State Acceptance

This criterion addresses the State's apparent preferences among or concerns about the various alternatives. State Acceptance will be addressed as part of the final decision-making process during the preparation of the ROD.

6.3.2 Community Acceptance

This criterion addresses the community's apparent preferences among or concerns about the various alternatives and will be addressed as part of the final decision-making process during the preparation of the ROD.

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Tables

Figures

Appendices

Appendix A

Arsenic and Lead Soil Volume Estimates

Appendix B

Estimated Costs for Remedial Alternatives